MARTIAN MASEKLYNITE? RAMAN SPECTRA OF PLAGIOCLASE-COMPOSITION GLASSES FROM ALH 84001, EETA79001, AND ALHA77005. Allan Treiman[1] and Patrick Treado[2], [1] Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058 (treiman@lpi.jsc.nasa.gov). [2] ChemIcon Inc., 7301 Penn Avenue, Pittsburgh PA 15208 (chemicon@chemimage.com).

Raman spectra of plagioclase-composition glasses from three martian meteorites show only broad scattering bands, while crystalline plagioclase and shock glass from Manicouagan (Que.) show sharp scattering maxima. Apparently, the martian meteorites were heated sufficiently during shock to effectively disorder their plagioclase-composition glasses, while the Manicouagan glass was heated less. These results bolster earlier conclusions that the term 'maskelynite' is inappropriate for physical studies. Raman spectroscopy does show great potential as a probe of ordering states of plagioclase-composition materials.

Introduction. Plagioclase is a sensitive indicator of shock and thermal history. At shock pressures above ~29 GPa, plagioclase transforms to a diaplectic glass, which has been known as maskelynite. At pressures above ~ 45 GPa, plagioclase melts, and can cool to a melt glass. On slow cooling, maskelynite reverts to its original crystals, while melt glass devitrifies to fine needles and radiating laths of plagioclase.

Glass of plagioclase composition in ALH 84001 was called maskelynite [1], but Scott et al. [2] found evidence that the glass had been molten. To explore this difference, it is important to distinguish maskelynite from melt glass in thin section. IR spectra are not diagnostic (3), so we investigated whether Raman spectroscopy could be useful (as did [4]).

Methods and Samples. Raman analysis was performed using a ChemIcon FALCON Raman microscope. Laser excitation was provided by a 532 nm Nd:YAG laser, which yields 0.2 - 2.0 Watts of power (at the laser exit aperture). The laser excitation was coupled into the FALCON system via a 200-micron diameter fiber optic cable. Sample excitation and Raman scatter collection was performed using a 50 X objective (NA=0.80) on the Raman microscope. Spectra were collected using up to 1 W of power as measured at the sample, into a spot of 60 microns diameter. Rayleigh scatter was rejected using high efficiency holographic filters.

Spectra were collected from ~250 through ~1600 cm^{-1}, and calibrated against Kr emission lines. Raman spectra were acquired of plagioclase-composition glasses from: ALH 84001,7; ALHA77005,137 [5]; and EETA79001,367 [6]. For comparison, we collected spectra from terrestrial maskelynite (Manicouagan impact structure [3]), plutonic labradorite, and andesine from a basalt. Raman scattering from mounting epoxy was observed in all thin section spectra, and was removed by spectra subtraction.

Results. Raman spectra of crystalline feldspars (Fig. 1) were consistent with earlier results [7]: a quadruplet of emissions at ~400, 490, 510, and 550 cm^{-1}, and broader emissions near 780 and 1050 cm^{-1}. Peaks were sharper for the labradorite than the andesine, consistent with greater ordering in the plutonic feldspar. The Manicouagan maskelynite has Raman spectra substantially identical to the volcanic andesine (Fig. 1). However, infrared absorption spectra of this maskelynite is substantially identical to plagioclase melt glass [3].

Plagioclase composition glass in EETA79001 is classic maskelynite: optically isotropic and amorphous to X-ray [8]; preserved igneous zoning of composition; and relict grain boundaries and twin planes preserved as variations in refractive index [6,8]. The EETA79001 maskelynite does not show the sharp Raman emissions of crystalline feldspar and Manicouagan maskelynite (Fig. 2). Rather, it shows broad emissions centered near the 490, 550, and 780 cm^{-1} bands of crystalline plagioclase. Similar Raman spectra have been reported from 'maskelynite' in Shergotty [4].

ALHA77005 contains plagioclase melt glass [5]: vesiculated, recrystallized at its edges to fine needles, and with schlieren indicating mixing with olivine- and pyroxene-composition glasses. The Raman spectra of the plagioclase melt glass (Fig. 2) is like that of EETA79001 — only broad emission bands.

Finally, Raman spectra of plagioclase composition glass in ALH 84001 were taken from three areas, one of which was vesiculated. All of these spectra were like the melt glass of ALHA77005 — only broad Raman emissions (Fig. 2).

Conclusions. Raman spectra of felspathic glass in ALH 84001 are similar to those of recognized maskelynite in EETA79001 and to those of melt glass in ALHA77005, but not to maskelynite from Manicouagan. This apparent ambiguity from Raman spectra supports inferences that 'maskelynite' is not a useful concept in microstructural or mineral-physical investigations [3,4]. However, 'maskelynite' is still a useful petrographic term for describing optically isotropic feldspar-composition material pseudomorphous after crystalline feldspar.

Our results suggest that Raman spectroscopy has an important place in understanding shocked feldspathic materials. The Raman spectra of Manicouagan maskelynite (like crystalline feldspar) are likely sensing its small domains (~ 8 nm across) of crystalline feldspar that are apparent in X-ray diffraction [3]. The abundance and structures of these crystalline domains are related to the time-temperature-pressure history of glass [3], and may be quantifiable as a tracer of shock and thermal history. Raman spectroscopy will be an important probe of these crystalline domains, as Raman is rapid and non-destructive, and permits significantly better spatial resolution than X-ray diffraction.

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[1] Mittlefehldt D.W., *Meteoritics* **29**, 219 (1994). Treiman A.H. *Meteoritics* **30**, 294 (1995). [2] Scott E.R.D. et al. *Nature* **387**, 377. Scott E.R.D. et al., *Lunar Planet. Sci.* **XXVIII**, 1271 (1997). [3] Arndt J. et al., *Phys. Chem. Mineral.* **8**, 230 (1982). Diemann E. & Arndt J., *Phys. Chem. Mineral.* **11**, 178 (1984). [4] El Goresy A. et al., *Meteoritics* **32**, 214 (1997). [5] Ikeda Y., *Proc NIPR Symp.* **7**, 9 (1994). [6] McSween H.Y.Jr. and Jarosewich E., *G.C.A.* **47**, 1501 (1983). [7] e.g., Wang et al., *J.G.R.* **100**, 21189. Haskin et al., *Lunar Planet. Sci.* **XVIII**, 523 (1997). [8] Steele I. and Smith J.V., *Proc. LPSC* **13**, A375 (1982).

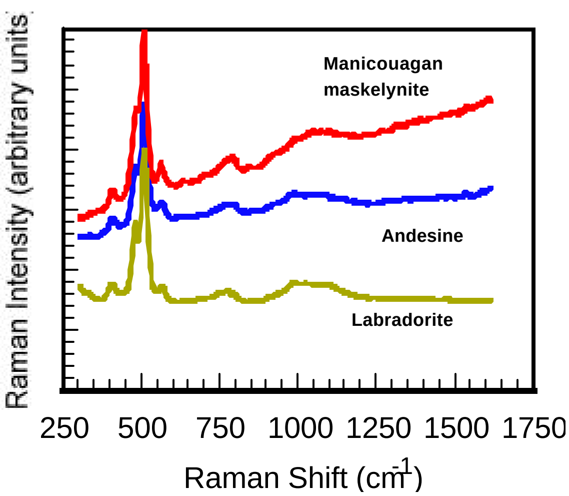

Figure 1. Raman spectra of terrestrial feldspar materials. Intensity values with arbitrary scales and offsets to aid in comparison. Plutonic labradorite from Labrador; volcanic andesine from Utah. Note quartet of sharp emissions near 500 cm^{-1}, and broader emissions near 800 and 1050 cm^{-1}.

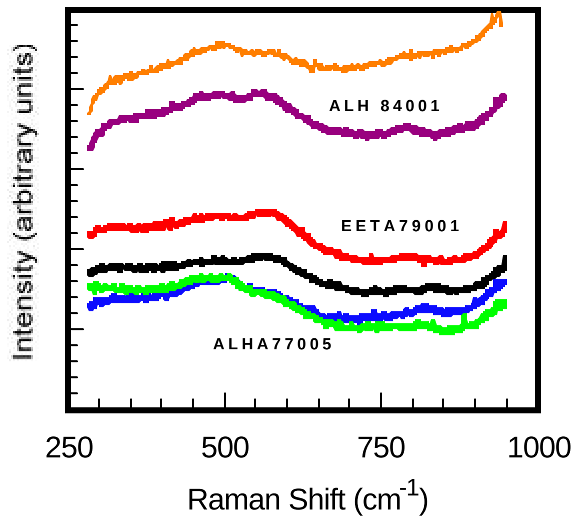

Figure 2. Raman spectra of feldspar glasses from martian meteorites. Intensity values with arbitrarily scales and offsets to aid in comparison. Bottom two spectra (overlapping) are vesicular glass from ALHA77005; middle two spectra are classic maskelynite from EETA79001. Note broad emission peaks near 480 and 520 cm^{-1}, similar to two of the sharp felspar emissions of Fig. 1.